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Applicant: Dai-Nippon Ink Chemical Industry Co., Ltd.

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SPECIFICATION

1. Title of the Invention

LARGE-SIZE CONTAINER

2. Claim:

A large-size container of high strength produced by integrating high-molecular-weight or ultra-high-molecular-weight polyolefin resin container structures of which the inner surfaces are coated or laminated with a resin highly resistant to chemicals and having good gas-barrier properties, in a mode of high-frequency welding or friction welding.

3. Detailed Description of the Invention:

The present invention relates to a large-size container produced by welding 2-layered or 3-layered container structures, which is extremely strong and highly resistant to chemicals and has good bas-barrier properties.

Containers composed of a main layer of polyolefin having a molecular weight of at least 250,000, an inner layer of polyamide

resin which is t make the main layer resistant to chemicals and have barrier properties, and an interlayer of unsaturated carboxylic acid-modified polyolefin which is to bond the two layers have already been proposed for large-size containers that are strong and resistant to chemicals and have good gas-barrier properties.

For producing the containers proposed, a multi-layered parison is formed through extrusion, and the parison is blow-molded.

Blow-molding is effective in producing containers of a relatively simple shape from raw resins of relatively good flowability, but is unfavorable for producing containers of a complicated shape from resins of low flowability, since moldings of a desired design are difficult to obtain in blow-molding. Blow-molded containers often have a thinner wall part than the designed thickness. The material of the polyamide resin layer which is to make the container structure resistant to chemicals and have gas-barrier properties is expensive, and the layer is satisfactorily effective even though it is thin. Therefore, in particular, the designed layer of the polyamide is desired to be as thin as possible. However, it is extremely difficult to make the thin layer have a uniform thickness in blow molding.

In addition, blow-molded containers could not be so designed that a baffle is inserted thereinto. A baffle, if installed in containers, is effective for preventing the

containers filled with fluid from giving a noise of the fluid when the containers are vibrated, and is effective for preventing the containers from being deformed. Further, rotary molding requires a long molding cycle and could not form thin layers with ease.

The present invention has been made in consideration of the above-mentioned matters, and is based on a technique of dividing a container into 2 or more container structures, separately forming the respective container structures in a mode of injection-molding, and then integrating them into one container by the use of a friction welder.

More precisely, high-density polyethylene (hereinafter referred to as HDPE) or ultra-high-molecular-weight high-density polyethylene (hereinafter referred to as EHDPE) is injection-molded to form the outer layer of each container structure that constitutes the essential part of the container of the invention.

For laminating or coating the inner surface of the outer layer of each container structure with an inner layer that acts to improve the chemical resistance and the gas-barrier properties of the container, various methods may be employable. Some typical examples of the methods are mentioned below.

a) A chemical-resistant and gas-barrier sheet of nylon 6 or 11 or the like is pre-formed by the use of a vacuum-forming machine or an air-pressure forming machine in accordance with

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the shape of th inner wall of each container structure, the pre-formed sheet is applied to the core of a male mold of an injection-molding machine, and then EHDPE is injected thereover to obtain a container structure of which the outer layer is made of EHDPE and the inner layer is a barrier layer of nylon.

In case where the adhesiveness between EHDPE and nylon is desired to be increased, a nylon sheet laminated with a sheet of unsaturated carboxylic acid-modified polyethylene is pre-formed in the same manner as above and the modified polyethylene layer may serve as an interlayer.

b) In forming container structures each composed of an outer layer and an inner layer, an outer layer part is first injection-molded, some through-holes are formed through the outer layer part, a barrier layer of a heated nylon sheet or the like is attached to the inner surface of the outer layer, and air is sucked out through the through-holes so that the nylon sheet is airtightly adhered to the inner surface of the outer layer to obtain a container structure. In this case, an adhesive may be previously applied to the inner surface of the outer layer. The through-holes made through the outer layer are sealed up by inserting rod chips of the same material as that of the outer layer followed by welding them by the use of a welder.

c) Resin powder such as powdery nylon to form a barrier layer is sprayed on the inner surface of a pre-formed outer layer of a container structure to form a barrier layer thereon, thereby

obtaining a container structure.

The 2-layered or 3-layered container structures thus formed according to any of the methods mentioned above are then integrated into a large-size container by welding them at their welding surfaces by the use of a friction welder or a high-frequency welder. Prior to welding the container structures into a container, a baffle or the like of a desired shape may be disposed inside any of them, and the container thus having the baffle therein may have the effect mentioned above.

In addition to nylon mentioned above, the material usable for the gas-barrier inner layer may be any of ethylene-vinyl acetate copolymer (EVA), or other chemical-resistant and gas-barrier resins.

Having the constitution as above, the container of the invention can be formed with ease and with accuracy. It may be of any complicated shape, its strength, chemical resistance and gas-barrier properties are surely good, and a baffle can be installed therein. Therefore, the container is very suitable for automobile fuel tanks, especially for gasoline tanks for passenger cars. In addition, it has many other applications for, for example, transportation and storage of other various oils, chemicals, poisons, etc.

Examples of the invention are described below.

Example 1:

Container structures composed of an outer layer (3 mm),

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an interlayer (0.1 mm) and an inner layer (0.1 mm) were formed according to the method a) mentioned above, for which ultra-high-molecular-weight high-density polyethylene, Showa Yuka's SHOLEX 4551H was used for the main layer, or that is, the outer layer; nylon-11, Organico's Rilsan, or EVA, Kuraray's Eval for the inner layer; and unsaturated carboxylic acid-modified polyethylene for the interlayer. Using a friction welder, the container structures were integrated, and the resulting container was tested for gasoline permeation therethrough. The test result is given in Table 1. The conditions for producing the container and for testing it are mentioned below.

[Molding]

Injection-molding machine: Mitsubishi Natoco 400 tons.

Cylinder temperature: former part, 270°C; center part, 255°C; latter part, 240°C.

Injection pressure: high pressure, 145 kg/cm^2; retention pressure, 130 kg/cm^2.

Screw revolution: 39 rpm.

Welder: friction welder.

Container capacity: 500 cc.

[Measurement of gas permeation]

Method: The container to be tested is filled with gasoline, and its weight is measured. This is left for 1 day, and its weight is measured. From the data, obtained is the total gasoline

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permeation through the container, and this is divided by the surface area of the container. The resulting value indicates the gasoline permeation/cm^2·day, through the container tested. The container is tested in a room at 40°C.

Table 1

Container Tested	
EHDPE alone	gr/day·cm^2 3×10^{-3}
EHDPE Modified polyethylene EVA	1.3×10^{-3}
EHDPE Modified polyethylene Nylon-11	1.1×10^{-3}

The molded container was tested for the friction welding strength.

Welding condition:

Air pressure, 6.0 kg/cm^2,

Welding time, 6.0 sec,

Weld pitch: 3.0 mm,

Weld width: 4 mm.

(1) Hydraulic test:

Using a hydraulic tester, high-pressure water is injected into the container to be tested, and the strength at break of the welded part of the container is measured.

Result: No water leaked out through the welded part of the container tested, under a pressure not higher than 8 kg/cm^2G.

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(Under a pressur higher than it, the stopper fell out, and the container could not be tested any more.)

(2) Drop and impact test:

The container to be tested is filled with water, and dropped onto a flat concrete surface so that its welded part collides against it.

Result:

Not cracked, when the container was dropped from a height of 2 m or shorter.

Partly cracked, when the container was dropped from a height of 2 to 3 m.

(3) Tensile strength test:

A strip of 25 mm wide with the welded part being the center thereof is sampled from the container to be tested, and its tensile strength is measured with a Shimadzu Seisakusho's autograph, IS-5000, in a room at 20°C, at a pulling rate of 10 mm/min.

Result:

The tensile strength of the sample tested fell between 240 and 260 kg/cm^2, not significantly differing from that of the nude substrate. (The tensile strength of the nude substrate was 290 kg/cm^2.)

Patent Applicant: Dai-Nippon Ink Chemical Industry Co., Ltd.